Claims

Method and Device for Damping Vibrations

1. Method for damping vibrations on chassis bearings of motor vehicles, **characterized in that** the driving state of the motor vehicle and/or the roadway conditions are detected by way of sensors and that the at least one chassis bearing (22, 24, 29) is modified to different characteristics to change its stiffness and/or damping depending on the detected parameters.

2. The process as claimed in claim 1, **wherein** the chassis bearing (22, 24, 29) is switched to different characteristics.

3. The process as claimed in claim 1 or 2, **wherein** depending on the roadway conditions an opposing vibration is superimposed on the chassis bearing (22, 24, 29).

4. The process as claimed in one of more of the preceding claims, **wherein** for defined driving states of the motor vehicle a setting of the chassis bearing (24) which increases the driving safety has priority.

5. The process as claimed in one of more of claims 1 to 4, **wherein** for several chassis bearings (24) with superposition of an opposing vibration the chassis bearings (24) are triggered separately and depending on their specific vibration excitation separately from the roadway.

6. The process as claimed in one of more of claims 1 to 5, **wherein** the roadway conditions can be detected on the front axle (12) of the motor vehicle by way of path and/or acceleration sensors (34), wherein the corresponding signals are processed in a control device (30), and wherein the chassis bearings (24) by way of power amplifiers are supplied with electricity or exposed to electromagnetic fields, and/or by way of piezoelements.

7. The process as claimed in one of more of claims 1 to 6, **wherein** a rapid modification of the characteristic of at least one chassis bearing (24) on the rear axle (14) is controlled by way of the roadway states which have been detected on the front axle (12) of the motor vehicle.

8. A device for implementing the process as claimed in one or more of the preceding claims, with sensors for detecting the driving state of the motor vehicle and for roadway conditions, with an electronic control device (30; 96) for processing of the acquired signals and for selection of various controllable characteristics, and at least one chassis bearing (24), the stiffness and/or damping of which can be modified.

9. The device as claimed in claim 8, **wherein** the chassis bearing (24) can be switched in four different characteristics (1 to 4) from low stiffness and low damping to high stiffness and high damping.

10. The device as claimed in claim 8 or 9, **wherein** the chassis bearing (24) has an outer bush (42; 82, 108) and an inner bush (40; 80; 106) between which there is at least one rubber-elastic support body (44; 84; 110), and wherein in the support body hydraulically acting working chambers (50, 58, 60, 70, 72) are formed which change the stiffness and the damping action of the chassis bearing (24) by switching means (56, 62, 74).

11. The device as claimed in claim 10, **wherein** some working chambers (58, 60) act in the axial direction and other working chambers (70, 72) act in the radial direction, and wherein the two working chambers can be switched into two damping action positions by way of choke elements (52, 54, 62, 66) which can be modified by the switching means (56, 64, 74).

12. The device as claimed in claims 10 and 11, **wherein** the radially acting working chambers (50) are mounted within the rubber-elastic support body (44) of the chassis bearing (24), and the connection between the working chambers can be controlled either by way of an annular

choke channel (52) of greater choke action or by way of a short circuit channel (54) with lesser choke action.

13. The device as claimed in claims 10 to 12, **wherein** the axially acting working chambers (58, 60) are mounted within the rubber-elastic support body (44) of the chassis bearing (24) and wherein the connection between the working chambers can be controlled either by way of an annular choke channel (62) of greater damping action or by way of a short circuit channel (66) with lesser damping action.

14. The device as claimed in claim 10, **wherein** the hydraulic working chambers (70, 72) which change the stiffness of the chassis bearing (24) are mounted within the rubber-elastic support body (44) of the chassis bearing (24) and wherein the connection between the working chambers can be closed or opened in a controlled manner.

15. The device as claimed in one or more of claims 8 to 14, **wherein** the switching means are slide valves (56, 64, 74) which can be electromagnetically actuated and which open or close the indicated connections in a controlled manner.

16. The device as claimed in one or more of claims 8 to 15, **wherein** a membrane (86) which can be actuated by way of an actuator (94; 98) for producing opposing vibrations is adjacent to one of the hydraulic working chambers (50) of the chassis bearing (24').

17. The device as claimed in claim 16, **wherein** the membrane (86) can be set into opposing vibration by means of a piezoelement (94) which can be electrically triggered.

18. The device as claimed in claim 17, **wherein** the piezoelement (94) actuates a lever (88) which is coupled to the housing section (92) of the chassis bearing (24') and which converts the stroke of the piezoelement (94) into a larger membrane stroke.

19. The device as claimed in claims 16 to 18, **wherein** the piezoelement (94) is mounted laterally to the chassis bearing (24') and wherein the membrane (86) or the opposing vibrations act in the vertical direction (Z direction) of the motor vehicle.

20. The device as claimed in claims 16 to 19, **wherein** the working chamber (50) with an integrated choke channel (52) forms a damping element which acts in the X direction and is embedded in the rubber-elastic support body (84) of the chassis bearing (24'; 24"), the membrane (86) representing one boundary wall of the support body (84).

21. The device as claimed in one or more of claims 16 to 20, **wherein** the membrane (86) is actuated by means of an electrodynamic actuator (98) with a current-carrying plunger coil (104) and a permanent magnet (100).

22. The device as claimed in claim 21, **wherein** the permanent magnet (100) is connected securely to the inner bush (80) of the chassis bearing (24") and wherein the plunger coil (104) interacts vibrating freely with the membrane (86) to produce the opposing vibrations.

23. Device as claimed in one or more of claims 8 to 22, **wherein** an additional spring (111) can be connected to the hydraulically damped chassis bearing (24"') by means of an actuator (114).

24. The device as claimed in claim 23, **wherein** the additional spring (111) can be connected by way of a multiple-disk clutch (112).

25. The device as claimed in claim 23 and 24, **wherein** the multiple-disk clutch (112) can be connected or disconnected by way of an electrically triggerable piezoelement (114).

26. The device as claimed in one or more of claims 22 to 25, **wherein** the multiple-disk clutch (112) is mounted on the inner bush (106) of the chassis bearing (24"') and in the direction transversely to the latter has one degree of freedom.

27. The device as claimed in one or more of claims 22 to 26, **wherein** the rubber-elastic additional spring consists of two buffers (111) which are located diametrically opposite and which can be coupled by way of the clutch disks to the inner bush (106), and the clutch disks can be released or pressed together by means of the piezoelement (114).

28. The device as claimed in one or more of claims 22 to 27, **wherein** the additional spring (111) acts in the vertical direction (Z direction) and longitudinal direction (X direction) of the motor vehicle and the degree of freedom of the multiple-disk clutch (112) is in the transverse direction (Y direction).

29. The device as claimed in one or more of claims 22 to 28, **wherein** the electrical piezoelement (114) is mounted transversely to the center axis of the chassis bearing (24"') and acts on the multiple-disk clutch (112) by way of a pressure plate (116) and a pretensioning spring (118).

30. The device as claimed in one or more of claims 8 to 29, **wherein** the chassis bearing (24) is one or more auxiliary frame bearings of an auxiliary frame which is mounted on the front axle (12) and/or the rear axle (14) of the motor vehicle.

31. The device as claimed in one or more of claims 8 to 30, **wherein** the chassis bearing (22, 29) is one or more arm bearings of a suspension arm (16) which is mounted on the front axle (12) and/or the rear axle (14) of the motor vehicle.